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U.S. Fish and Wildlife Service
Pierre, South Dakota

Lake Thompson
Kingsbury County
South Dakota

A REPORT ON TRACE ELEMENT CONCENTRATIONS IN SEDIMENTS, VEGETATION, AND FISHES FROM THE LAKE THOMPSON WETLAND COMPLEX, SOUTH DAKOTA

INTRODUCTION

The Lake Thompson Basin is located in Kingsbury County near the town of DeSmet in eastern South Dakota. A Waterfowl Production Area (WPA) is located along the southeast edge of Lake Thompson and features a large wetland complex that has recently been added to the National Wildlife Refuge System. There are approximately 30 other WPA's within the Lake Thompson Basin. Lakes Preston, Henry, Whitewood, and Silver drain into the lake which receives drainage from a 506-square mile area consisting mostly of agricultural lands. In 1980 Lake Thompson was a 9,000-acre marsh. The draining of numerous wetlands to create cropland, combined with heavy precipitation, raised the water level. Now Lake Thompson, with a surface area of 16,000-acres, is the largest natural lake in South Dakota. Fish, especially northern pike and bullhead, are abundant in Lake Thompson.

JUSTIFICATION

Lake Thompson is located in the southern reach of the Prairie Pothole Region. The South Dakota Department of Game, Fish and Parks owns approximately 2,400 acres, the Farmers Home Administration owns 300 acres, and the Service has 220 acres in fee title wetlands and 1,200 acres under easement in the vicinity of the lake (Figure 1). Most of the State lands are located along the southern edge of Lake Thompson and are not shown on the figure. Silver Lake, a wetland not shown in the figure, is located just south of DeSmet, South Dakota. The Lake Thompson Basin and its appurtenant wetlands are important migratory waterfowl staging areas for the Waubay National Wildlife Refuge to the north and the Lake Herman and Lake Madison wetland complexes to the south. Numerous ducks and other water birds nest on and near these wetlands.. Important species that frequent the wetlands, in addition to prairie ducks, are giant Canada geese, great blue herons, black-crowned night herons, great egrets, and double-crested cormorants.

OBJECTIVES

The objectives of this study were to determine if contaminants were present in Lake Thompson wetland complex sediments, vegetation, or fish at concentrations that would impair the health of waterfowl or reduce the quantity or quality of their habitats or foods.

SIGNIFICANT FINDINGS

Contaminant bioaccumulation is related to length of exposure time; therefore, adult fish and mature vegetation that have had longer exposure durations than younger organisms were collected for analyses.

Mature cattail roots and sediment grab samples from Silver Lake were collected from the west side opposite the old landfill and from the northwest corner opposite the old rendering plant. These collections were analyzed for 22 organochlorine compounds and octochlorostyrene, and only p,p'-DDE at 0.12 mg/kg dry weight was detected (Table 1).

The cattail and sediment samples from Silver Lake were analyzed for 13 aliphatic hydrocarbons (Table 2). Aliphatic hydrocarbons were detected in cattails. In sediments, no aliphatics were detected in one sample, and six were detected at concentrations of 0.43 mg/kg or lower in the other sample.

The concentrations of hydrocarbons, of which aliphatics are a component, can be used to classify the extent of sediment pollution. Highly polluted sediments from coastal areas contain hydrocarbon concentrations ranging between 100 and 12,000 mg/kg with most concentrations being less than 1,000 mg/kg. Hydrocarbon concentrations in unpolluted coastal areas and deep seas are usually below 70 mg/kg. The cleanest sediments from remote deep sea areas contain total hydrocarbon concentrations of less than 2 mg/kg. By comparison, based on hydrocarbon concentration, the Lake Thompson sediments rank as some of the cleanest in the world.

Many hydrocarbon compounds occur and break down naturally in the environment. Little toxicity information is available on them. There is no indication that they are a problem in the Lake Thompson complex; therefore, based on current data, the biological impacts of the concentrations detected in sediments are presently considered insignificant.

Cattail and sediment samples were analyzed for inorganic elements (Table 3). Inorganic concentrations were generally higher in sediments than in vegetation, and all were within the normal range reported for uncontaminated sediments.

Individual whole-body inorganic element analyses were performed on northern pike, walleye, bullhead, or carp from Lake Thompson, Lake Henry, and Lake Whitewood (Table 4). Elements of greatest concern, cadmium (Cd), mercury (Hg), selenium (Se), and arsenic (As), were present at relatively low levels in fish, except for Hg. The two highest Hg concentrations were 6.2 mg/kg dry weight (1.34 mg/kg wet weight) and 4.2 mg/kg dry weight (0.97 mg/kg wet weight) in two northern pike from Lake Thompson. These concentrations are just above and just below the Food and Drug Administration Action Level of 1.0 mg/kg wet weight for Hg in edible fish tissue. The highest Hg concentrations are usually in the muscle tissue of fish, especially large fish; therefore, it is possible that, had fillets been analyzed in this study instead of whole fish, the concentrations detected would have been higher.

Other studies have reported that Hg residues ranged from 5 to 7 mg/kg wet weight in whole-body fish that died from Hg poisoning. Hg levels in fish from this study were all well below the concentration reported to be lethal. It is common, when new areas are flooded, for Hg in fish to become elevated for a number of years and then decline to background levels.

Se concentrations were about equal in all fish species and ranged between 0.82 and 1.6 mg/kg dry weight (Table 4). Whole-body concentrations of Se in the 5 to 8 mg/kg range have been reported to be lethal to young fish, which are more sensitive than adult fish. The highest Se concentration detected in this study was below the concentration expected to impair fish health.

Arsenic was detected in northern pike, walleye, bullhead, and carp at concentrations ranging between <0.1 and 0.38 mg/kg dry weight (Table 4). The average concentration of As in freshwater, estuarine, and marine fish collected throughout the United States ranged between 0.05 and 0.5 mg/kg wet weight. The highest As concentrations detected in Lake Thompson fish (0.38 mg/kg dry weight; 0.077 mg/kg wet weight) were within the normal range of values reported for fish from uncontaminated waters within the United States.

CONCLUSIONS

The results of this study identify the contaminants present, if any, and their concentrations in fish, cattail roots, and sediments from areas of concern in the Lake Thompson wetland complex. No organic compounds were present in the samples analyzed at concentrations expected to be toxic to waterfowl, their habitats, or their foods. Mercury was detected at above background concentrations in northern pike. Therefore, it is recommended that additional samples be collected from Lake Thompson in the future and analyzed for Hg to determine if it is having an impact on fish important in the diet of water birds or waterfowl production.

The Lake Thompson complex receives drainage from a large watershed composed of agricultural fields. Surrounding croplands are treated with herbicides and insecticides that have the potential to wash into local wetlands. Future studies should determine the presence and environmental effects of pesticides on these wetlands.

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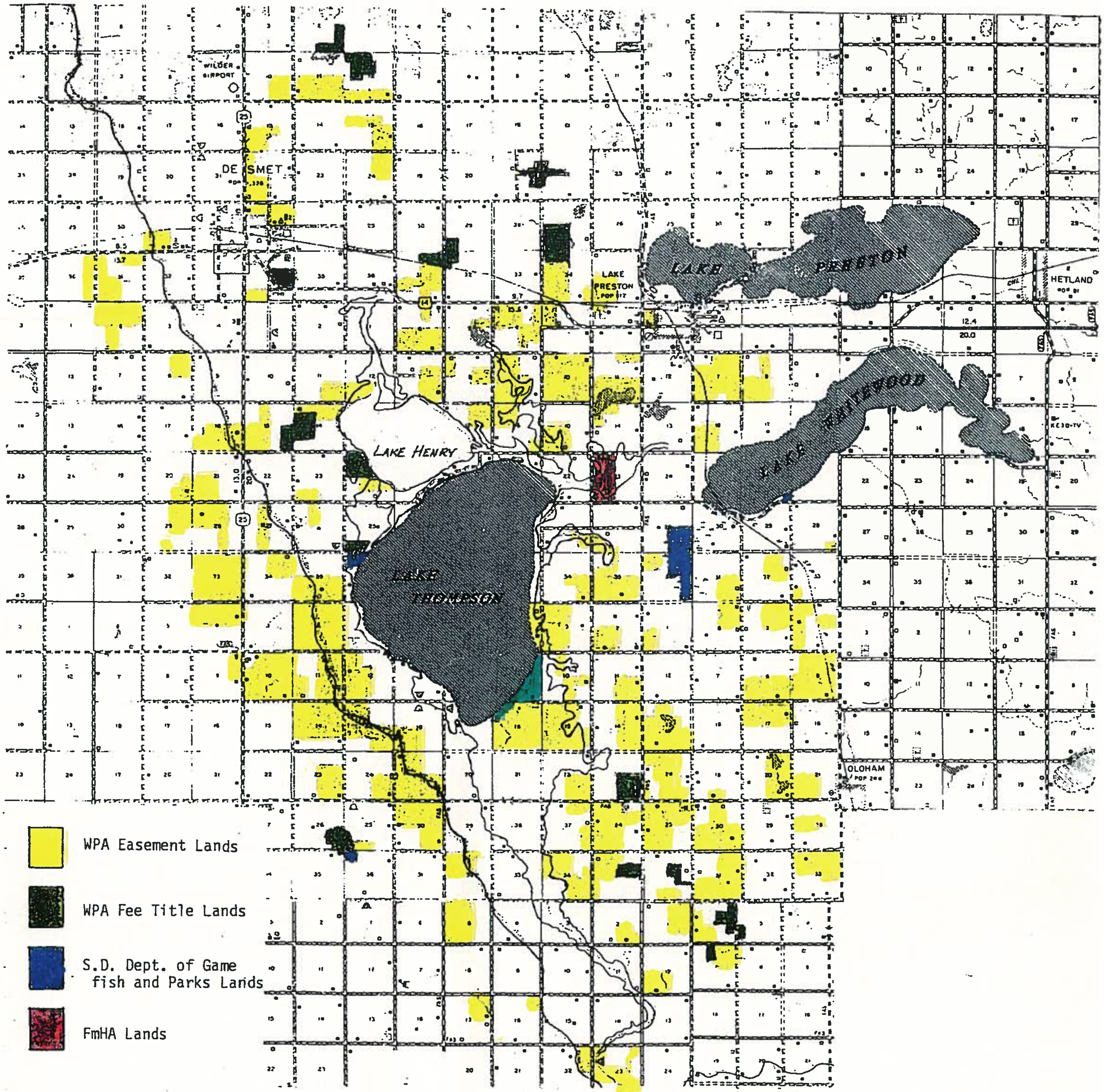

Figure 1. Lake Thompson Wetland Complex.

Table 1. Organic compounds analyzed for but not detected in two composite samples of whole cattails and two composite sediment samples collected in 1989 from Silver Lake on the Lake Thompson wetland complex.

Hexachloro benzene	Gamma chlordane	Deildrin
Alpha BHC	Nonachlor	o,p'-DDD
Beta-BHC	Toxaphene	Endrin
Delta-BHC	Polychlorinated biphenyls (Total)	cis-Nonachlor
Lindane	o,p'-DDE	o,p'-DDT
Oxychlordane	Alpha-chlordane	p,p'-DDD
Heptachlor epoxide	p,p'-DDE*	p,p'-DDT
		Mirex
		Octochlorostyren

*Detected at 0.12 mg/kg dry weight in one cattail sample.

Table 2. Concentrations (mg/kg dry weight) of aliphatic hydrocarbon compounds detected in two whole-cattail samples and two sediment samples collected in 1989 from Silver Lake in the Lake Thompson wetland complex.

	Identification No. and Matrix			
Compound	Cattail	Cattail	Sediment	Sediment
N-dodecane	0.34	0.16	ND*	ND
N-tridecane	0.90	0.43	ND	ND
N-tetradecane	2.04	0.66	ND	ND
Octylcyclohexane	0.68	0.22	ND	ND
N-pentadecane	4.77	1.48	0.10	ND
Nonylcyclohexane	2.27	0.71	ND	ND
N-hexadecane	8.06	2.41	ND	ND
N-heptadecane	15.90	4.94	0.43	ND
Pristane	10.11	3.18	ND	ND
N-octadecane	11.02	3.51	0.07	ND
Phytane	5.79	1.92	0.32	ND
N-nonadecane	5.56	1.86	0.07	ND
N-eicosane	2.04	0.77	0.07	ND
Moisture (%)	91.2	81.80	72.40	40.2

*ND indicates not detected.

Table 3. Concentration (mg/kg dry weight) of inorganic elements detected in one composite sample of whole cattails and one composite sediment sample collected in 1989 from Silver Lake in the Lake Thompson wetland complex. The standard ICP method was used to analyze the sediment sample and the preconcentration ICP method was used to analyze the plant sample. Arsenic and selenium were analyzed using the hydride generation method. The cold vapor reduction method was used to analyze for mercury.

	Identification No. and Matrix	
Element	Cattail	Sediment
Aluminum	1,550.00	9,600.00
Antimony	< 5.95	< 8.73
Barium	18.87	117.80
Beryllium	< 0.30	0.52
Boron	43.00	35.95
Cadmium	< 0.30	0.52
Chromium	2.26	16.05
Copper	10.83	25.13
Iron	1,900.00	12,000.00
Lead	< 1.79	13.20
Magnesium	4,270.00	10,700.00
Manganese	488.00	853.40
Molybdenum	2.98	< 4.36
Nickel	2.38	30.80
Silver	2.97	< 4.36
Strontium	52.56	109.07
Thallium	11.90	< 17.45
Tin	2.97	< 4.36
Vanadium	6.01	40.66
Zinc	79.16	72.25
Arsenic	1.19	5.06
Mercury	< 0.15	0.06
Selenium	< 0.60	1.57
Percent moisture	83.20	42.70

Table 4. Concentrations (mg/kg dry weight) of inorganic elements detected in whole-body fish collected from the Lake Thompson area, Kingsbury County, South Dakota in 1988. Fish lengths are in mm. Arsenic and selenium were analyzed using the hydride generation method. Mercury was analyzed using the cold vapor atomic absorption method. All other elements were analyzed using the inductively coupled plasma (ICP) method. Ag, Be, Pb, and Tl were analyzed for but not detected.

SPECIES	ID	LAKE	LENGTH	% MOISTURE	HG	SE	AS	AL	B	BA	CD	CR	CU	FE	MG	MN	MO	NI	SR	V	ZN
N. pike	2	Henry	638	78.6	1.40	0.82	<0.10	9	5.0	2.5	<0.2	<1	2.9	85	1480	35.8	<1	<1.0	35.5	<0.3	187.0
N. pike	3	Henry	609	80.8	1.30	0.94	<0.10	4	4.0	2.5	<0.2	2	2.7	72	1480	45.7	<1	2.0	39.5	<0.3	196.0
N. pike	4	Henry	653	76.5	2.10	0.89	<0.10	6	5.0	3.0	<0.2	1	2.2	68	1430	45.1	<1	<1.0	34.2	<0.3	204.0
N. pike	5	Henry	614	77.3	0.95	0.86	<0.10	<3	5.0	2.9	<0.2	2	2.1	58	1450	57.2	<1	<1.0	38.8	<0.3	238.0
N. pike	6	Henry	495	75.3	0.64	0.86	<0.10	<3	6.0	5.5	<0.2	3	2.7	70	1600	57.6	<1	<1.0	61.9	<0.3	231.0
N. pike	7	Henry	519	80.5	1.09	1.00	<0.10	11	5.0	3.1	<0.2	2	3.7	95	1510	33.5	<1	<1.0	37.2	<0.3	197.0
N. pike	8	Thompson	822	78.3	6.20	1.10	<0.10	<3	6.0	2.0	0.2	2	2.3	59	1400	43.0	<1	1.0	25.6	<0.3	222.0
N. pike	9	Thompson	757	76.3	4.10	0.98	<0.10	<3	6.1	1.4	<0.2	2	2.9	39	1330	36.9	<1	1.0	22.2	<0.3	199.0
N. pike	11	Thompson	537	79.5	2.60	0.88	0.30	<3	5.0	5.7	<0.2	2	2.5	73	1670	83.3	<1	<1.0	58.2	<0.3	306.0
N. pike	12	Thompson	427	78.9	2.10	1.00	0.10	<3	3.0	9.8	<0.2	2	2.9	69	1830	121.0	1	7.3	84.5	<0.3	215.0
N. pike	13	Thompson	382	78.4	2.30	0.86	<0.10	3	5.0	9.5	<0.2	3	3.4	72	1810	85.9	<1	1.0	77.4	<0.3	246.0
N. pike	14	Thompson	402	80.5	2.40	1.10	<0.10	<3	4.0	10.2	<0.2	2	2.8	90	1850	94.2	<1	2.0	83.4	<0.3	240.0
N. pike	19	Thompson	738	78.5	1.60	1.20	<0.10	8	4.0	3.2	<0.2	2	2.4	66	1350	49.8	<1	<1.0	26.6	<0.3	185.0
N. pike	20	Thompson	747	76.2	1.70	1.10	<0.10	<3	4.0	3.2	<0.2	1	2.6	55	1390	42.2	<1	<1.0	31.2	<0.3	194.0
N. pike	21	Thompson	733	76.3	0.71	1.10	<0.10	<3	<2.0	3.1	<0.2	2	1.9	61	1400	57.5	<1	2.0	34.2	<0.3	169.0
N. pike	39	Thompson	742	77.6	0.93	1.00	<0.10	23	3.0	3.2	<0.2	2	2.0	74	1350	52.8	<1	1.0	32.7	<0.3	167.0
Walleye	15	Thompson	336	73.3	1.90	1.00	0.20	<3	4.0	2.1	<0.2	2	1.5	49	1270	9.8	<1	<1.0	31.3	<0.3	49.8
Walleye	16	Thompson	332	74.9	1.70	1.30	<0.10	<3	<2.0	2.9	<0.2	2	1.1	52	1400	16.0	<1	1.0	40.8	<0.3	44.8
Walleye	17	Thompson	280	77.3	0.95	1.00	0.20	<3	<2.0	6.0	<0.2	2	1.4	40	1540	27.9	<1	1.0	72.8	<0.3	51.3
Walleye	18	Whitewood	517	70.0	0.92	1.30	<0.10	<3	3.0	3.1	<0.2	1	0.8	46	1140	20.4	<1	<1.0	22.5	<0.3	42.2
Walleye	24	Whitewood	412	73.5	0.61	1.40	<0.10	<3	2.0	4.1	<0.2	2	1.5	45	1350	28.6	<1	<1.0	31.1	<0.3	53.1
Walleye	25	Whitewood	437	73.1	0.76	1.50	<0.10	<3	<2.0	1.7	<0.2	3	1.5	38	1160	14.0	1	5.6	14.1	<0.3	40.5
Walleye	26	Whitewood	412	71.8	0.63	1.50	<0.10	<3	<2.0	4.0	<0.2	2	1.1	43	1250	37.2	<1	2.0	23.0	<0.3	46.8
Walleye	27	Whitewood	469	71.4	0.63	1.50	0.20	<3	<2.0	3.0	0.3	1	1.2	39	1160	27.5	<1	<1.0	19.1	<0.3	46.0
Walleye	28	Whitewood	391	70.4	0.57	1.30	0.30	<3	2.0	2.9	<0.2	2	1.4	48	1090	23.3	<1	<1.0	17.1	<0.3	43.8
Bullhead	22	Whitewood	218	81.4	0.16	0.98	0.38	14	3.0	14.0	<0.2	2	2.6	129	1620	77.3	<1	<2.0	108.0	0.4	94.0
Bullhead	29	Whitewood	226	81.6	0.16	0.95	0.34	13	3.0	11.8	<0.2	2	2.1	119	1640	86.7	<1	<2.0	111.0	<0.3	91.7
Bullhead	30	Whitewood	218	78.9	0.15	1.20	0.31	7	3.0	11.1	<0.2	2	3.7	147	1410	205.0	<1	<2.0	74.5	1.1	84.9
Bullhead	31	Whitewood	242	79.8	0.21	1.40	0.10	4	3.0	10.0	<0.2	1	2.2	114	1510	88.6	<1	<2.0	85.9	0.4	96.8
Bullhead	32	Whitewood	221	80.1	0.20	1.30	0.20	10	<2.0	9.1	<0.2	2	2.5	141	1510	54.6	<1	<2.0	86.9	0.3	106.0
Bullhead	33	Whitewood	215	81.8	0.15	1.20	0.30	27	3.0	10.3	<0.2	2	2.3	146	1550	79.2	<1	<2.0	88.0	0.5	102.0
Carp	35	Whitewood	558	69.1	0.08	1.30	0.20	<3	2.0	3.1	<0.2	1	2.6	61	894	6.7	<1	<2.0	40.5	<0.3	240.0
Carp	36	Whitewood	554	73.0	0.09	1.50	0.20	<3	<2.0	4.3	<0.2	2	3.1	73	1040	8.6	<1	<2.0	45.8	<0.3	268.0
Carp	37	Whitewood	423	76.6	0.07	1.60	0.30	8	<2.0	8.5	<0.2	2	3.3	68	1370	16.0	<1	2.0	69.9	0.3	277.0
Carp	38	Whitewood	532	73.6	0.09	1.30	0.20	10	<2.0	4.2	<0.2	2	2.8	83	1130	11.0	<1	<2.0	58.9	<0.3	242.0